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**RESULTS OF THE RADIOLOGICAL
SURVEY AT 90 C AVENUE, LODI,
NEW JERSEY (LJ079)**

R. D. Foley
L. M. Floyd

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HEALTH AND SAFETY RESEARCH DIVISION

Nuclear and Chemical Waste Programs
(Activity No. AH 10 05 00 0; ONLWCO1)

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(LJ079)**

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CONTENTS

LIST OF FIGURES	v
LIST OF TABLES	vii
ACKNOWLEDGMENTS	ix
ABSTRACT	xi
INTRODUCTION	1
SURVEY METHODS	2
SURVEY RESULTS	2
Gamma Radiation Levels	2
Systematic and Biased Soil Samples	3
SIGNIFICANCE OF FINDINGS	3
REFERENCES	4

LIST OF FIGURES

- 1 Gamma radiation levels ($\mu\text{R}/\text{h}$) measured on the surface at 90 C Avenue, Lodi, New Jersey (LJ079), with corresponding measurements one meter above the surface where indicated. 5
- 2 Gamma radiation levels ($\mu\text{R}/\text{h}$) measured inside the basement at 90 C Avenue, Lodi, New Jersey (LJ079) 6
- 3 Diagram showing locations of soil samples taken at 90 C Avenue, Lodi, New Jersey (LJ079) 7

LIST OF TABLES

1	Applicable guidelines for protection against radiation	8
2	Background radiation levels for the northern New Jersey area	8
3	Concentrations of radionuclides in soil at 90 C Avenue, Lodi, New Jersey (LJ079)	9

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ABSTRACT

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducted an investigative radiological survey during 1988 at 90 C Avenue, Lodi, New Jersey (LJ079), one of the properties in the vicinity of the MCW site. The survey included a gamma radiation scan of the surface and at one meter above the surface, as well as radionuclide sampling of surface and subsurface soil. The survey objective was to determine whether this site was contaminated with radioactive residues derived from MCW, principally ^{232}Th .

Results of the survey demonstrated radionuclide concentrations in excess of DOE remedial action criteria, primarily from the ^{232}Th decay chain, with some contamination from ^{226}Ra . The radionuclide distributions are typical of the type of material originating from the MCW site.

**RESULTS OF THE RADIOLOGICAL
SURVEY AT 90 C AVENUE
LODI, NEW JERSEY (LJ079)***

INTRODUCTION

From 1916 to 1956, process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores were generated by the Maywood Chemical Works (MCW), Maywood, New Jersey. During the latter part of this period, MCW supplied rare earth metals and thorium compounds to various government agencies. In the 1940s and 1950s, MCW produced thorium and lithium, under contract, for the Atomic Energy Commission (AEC). These activities ceased in 1956, and, approximately three years later, the 30-acre real estate was purchased by the Stepan Company. The property is located at 100 Hunter Avenue in a highly developed area in Maywood and Rochelle Park, Bergen County, New Jersey.

During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities. In the early 1930s, these areas were separated from the rest of the property by the construction of New Jersey State Highway 17. The Stepan property, the interim storage facility, and several vicinity properties have been designated for remedial action by the U.S. Department of Energy (DOE).

The waste produced by the thorium extraction process was a sandlike material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. During the years 1928 and 1944 to 1946, area residents used these process wastes mixed with tea and cocoa leaves as mulch in their lawns and gardens. In addition, some of the contaminated wastes were apparently eroded from the site into Lodi Brook and carried downstream.

Lodi Brook is a small stream flowing south from Maywood with its headwaters near the Stepan waste storage site. Approximately 150 ft after passing under State Route 17, the stream has been diverted underground through concrete or steel culverts until it merges with the Saddle River in Lodi, New Jersey. Only a small section near Interstate 80 remains uncovered. From the 1940s to the 1970s when the stream was being diverted underground, its course was altered several times. Some of these changes resulted in the movement of contaminated soil to the surface of a few properties, where it is still in evidence. In other instances, the contaminated soil was covered over or mixed with clean fill, leaving no immediate evidence on the surface. Therefore, properties in question may be drilled in search of former stream bed material, even in the absence of surface contamination.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the property discussed in this report and properties in its vicinity contaminated with residues from the former MCW were included as a decontamination research

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

and development project under the DOE Formerly Utilized Sites Remedial Action Program. As part of this project, DOE is conducting radiological surveys in the vicinity of the site to identify properties contaminated with residues derived from the MCW. The principal radionuclide of concern is thorium-232. The radiological surveys discussed in this report are part of that effort and were conducted, at the request of DOE, by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory.

A radiological survey of the private, residential property at 90 C Avenue, Lodi, New Jersey, was conducted during 1988. The survey and sampling of the ground surface were carried out on May 4, 5 and 9, 1988.

SURVEY METHODS

The radiological survey of the property included: (1) indoor and outdoor gamma scans of the entire property, both at the surface and one meter above the surface and (2) collection of surface and subsurface soil samples. The survey methods followed the plan outlined in Reference 1. A comprehensive description of the survey methods and instrumentation has been presented in another report.²

Using a portable gamma scintillation meter, ranges of measurements were recorded for areas of the property surface and one meter above the surface, as well as in each room of the house. Systematic soil samples were then obtained at randomly selected locations irrespective of gamma exposure rates. In addition, biased soil samples were collected in areas of elevated gamma levels. To initially examine possible subsurface soil contamination, the biased locations were sampled to depths of approximately 60 cm. Measurements were usually made at 15- or 30-cm intervals.

SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.³ The normal background radiation levels for the northern New Jersey area are presented in Table 2. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the property are given in Figs. 1 and 2. These measurements were taken outdoors and in each room of the house, both at the surface and one meter or more above the surface (Fig. 1). Figure 2 shows the measurements taken in the basement of the house. Gamma exposure rates at the surface over the major portion of the front and side yards outdoors ranged from 6 to 14 $\mu\text{R}/\text{h}$. One-meter readings in these areas were between 6 and 7 $\mu\text{R}/\text{h}$, below the normal background level of 8 $\mu\text{R}/\text{h}$ at 1 m for

the northern New Jersey area (Table 2). The strip of yard between the sidewalk and the street read $21 \mu\text{R/h}$. Measurements exceeding $100 \mu\text{R/h}$ were found in two areas, one at the footer on the eastern wall of the garage at ground level which read $110 \mu\text{R/h}$ ($11 \mu\text{R/h}$ at 1 m). The other, located approximately 8 feet above ground level on the eastern side of the house, south of the steps, measured $170 \mu\text{R/h}$. The gamma radiation at this point appeared to emanate from inside the eastern, exterior wall of the kitchen in a narrow band about 3 to 4 feet long and 6 to 10 inches wide. To the west of the garage, gamma levels were 13 to $64 \mu\text{R/h}$ at the surface and $14 \mu\text{R/h}$ at one meter. South and west of the house, surface readings ranged from 26 to $79 \mu\text{R/h}$.

Indoors, the background gamma radiation levels on the main floor measured between 4 and $9 \mu\text{R/h}$, at the floor and at 1 m. The highest reading were found in the kitchen, which was on the south side of the house. The floor of the kitchen measured 21 to $43 \mu\text{R/h}$, reading $21 \mu\text{R/h}$ in the center of the floor and $26 \mu\text{R/h}$ at 2 m (level with the cabinets). The inside of the kitchen cabinets on the eastern, exterior wall read $138 \mu\text{R/h}$; this measurement was opposite the $170 \mu\text{R/h}$ reading on the outside of the wall. Near the back door, gamma levels ranged from 64 to $85 \mu\text{R/h}$. The basement steps were in the southeastern corner of the main house and had readings of $53 \mu\text{R/h}$. In the north and south top corners of the basement beneath the eastern kitchen wall, gamma measurements were 64 and $43 \mu\text{R/h}$, respectively (Fig. 2). Gamma radiation levels in the kitchen and basement exceeded the DOE, indoor guidelines of $20 \mu\text{R/h}$ (Table 1).

Systematic and Biased Soil Samples

Systematic and biased soil samples were taken from various locations on the property for radionuclide analyses. Locations of the systematic (S) and biased (B) samples are shown in Fig. 3, with results of laboratory analyses provided in Table 3. Concentrations of radium, thorium, and uranium in these samples ranged from 0.73 to 13 pCi/g , 0.96 to 240 pCi/g , and <0.91 to $<50 \mu\text{R/h}$, respectively. All samples were near or above background levels for the northern New Jersey area (Table 2). Thorium levels in samples B1A, B2A, B3A-C, B6A, and B6D-G were above DOE guidelines (Table 1). The highest values were found in the B3 and B6 samples. Uranium concentrations were elevated in samples B3A&B, B4A, B6A, and B6E-G.

SIGNIFICANCE OF FINDINGS

Measurements taken at 90 C Avenue indicate that the property contained radioactive contamination primarily from the ^{232}Th and ^{238}U decay chains, with some contamination from ^{226}Ra . These radionuclide distributions are typical of the type of material originating from the MCW site. The source of the high gamma radiation levels on both sides of the eastern wall of the kitchen could not be determined without destruction of the wall. The radiation appeared to come from a horizontal source, rather than a vertical or point source. The kitchen was added during a remodelling of the original house. The source of the contamination in this wall could be from one or more pieces of lumber used in the remodelling. The concentration

and extent of ^{232}Th on this property were in excess of the applicable DOE criteria (Table 1). These materials were found at sample locations B1A, B2A, B3A-C, B4A, B6A, and B6D-G, shown in Fig. 3. Based on the results of this radiological assessment, it is recommended that this site be considered for inclusion in the DOE remedial action program.

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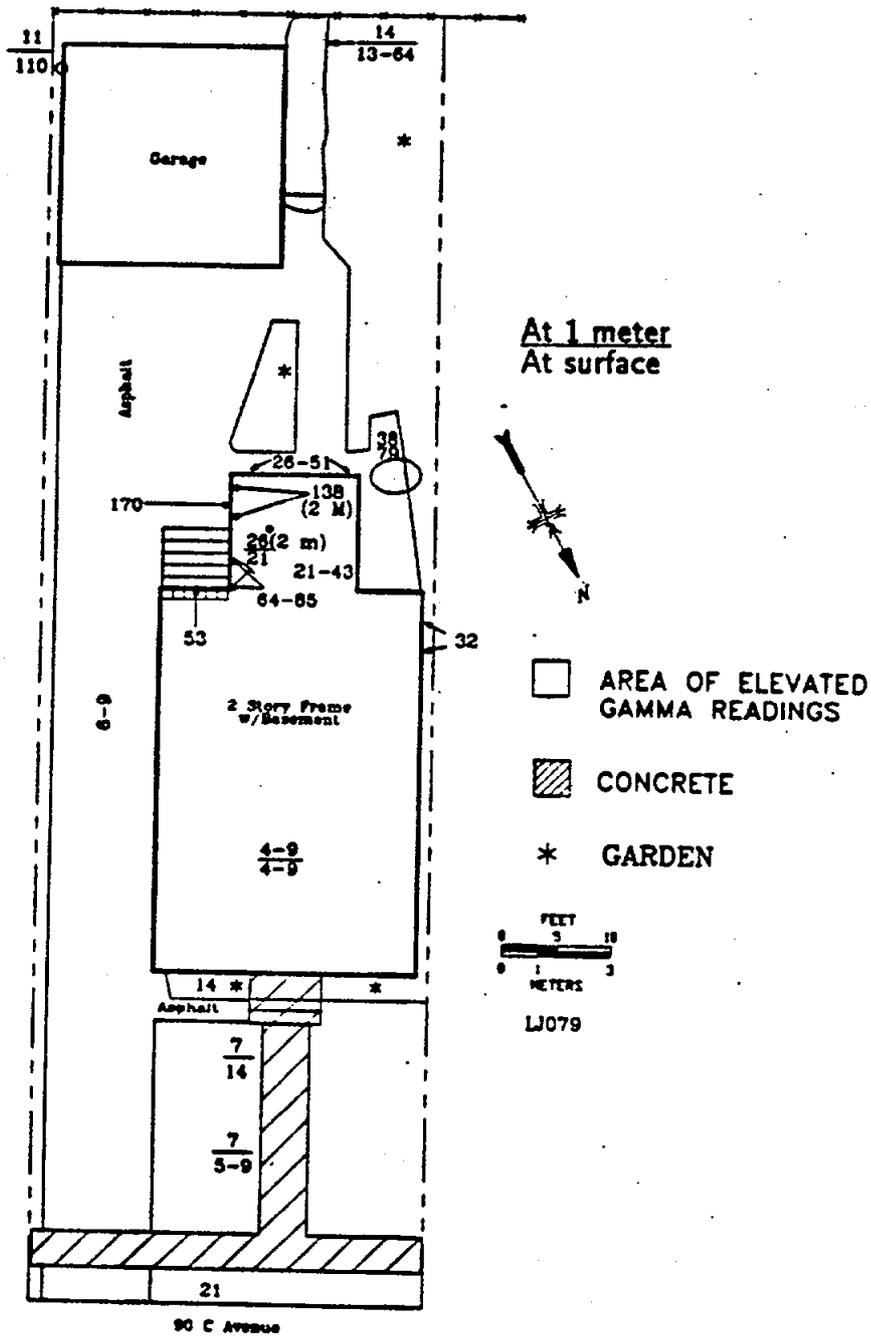


Fig. 1. Gamma radiation levels ($\mu\text{R}/\text{h}$) measured on the surface at 90 C Avenue, Lodi, New Jersey (LJ079), with corresponding measurements one meter above the surface where indicated.

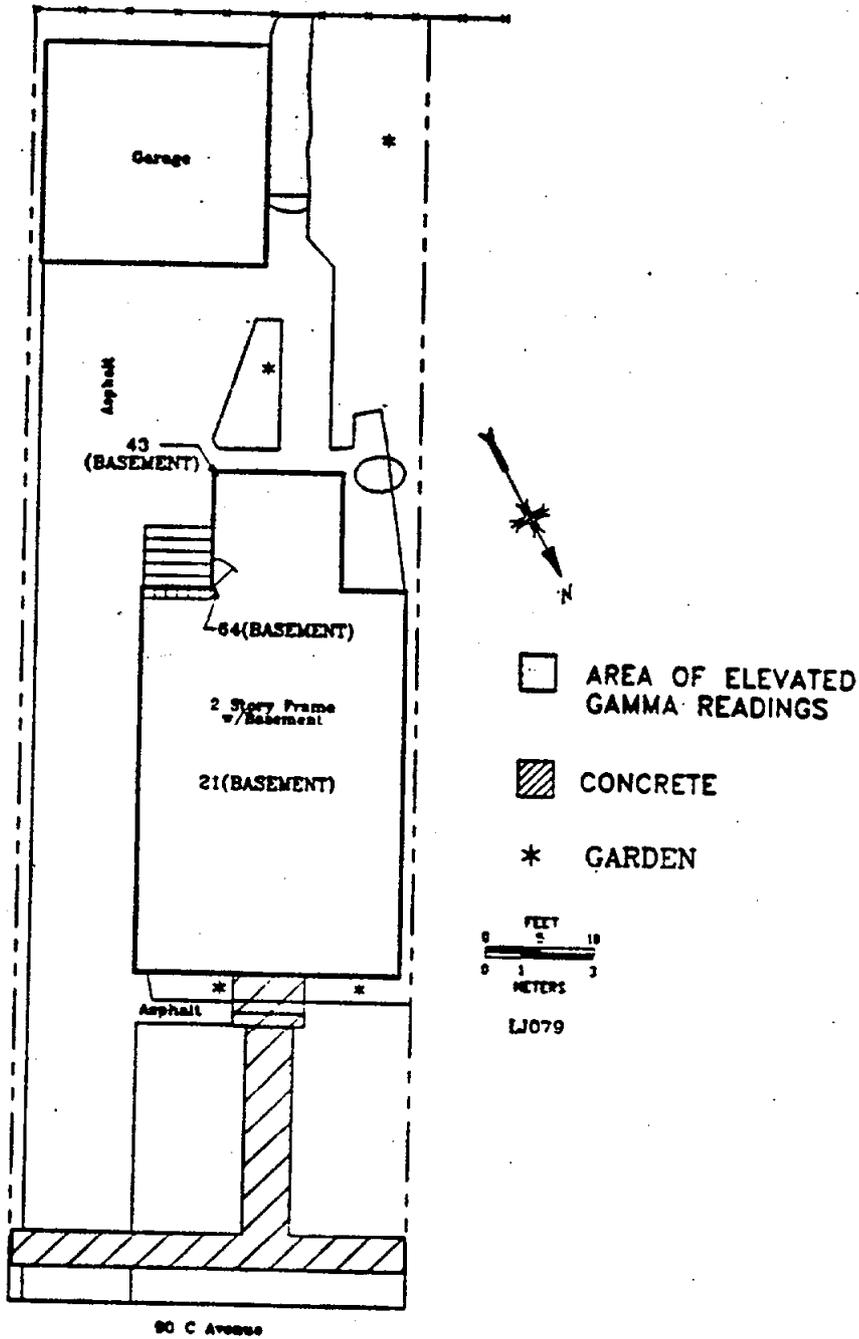


Fig. 2. Gamma radiation levels ($\mu\text{R/h}$) measured inside the basement at 90 C Avenue, Lodi, New Jersey (LJ079).

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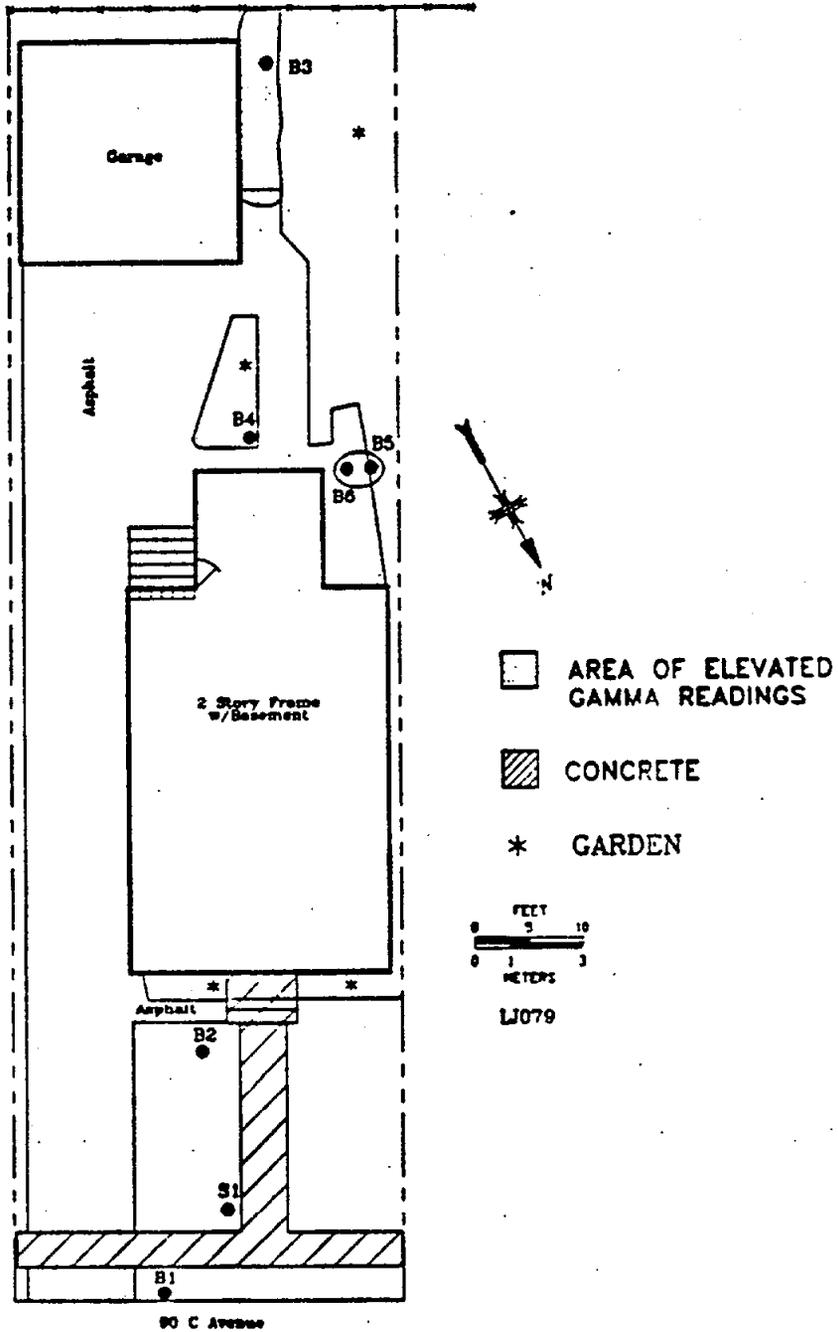


Fig. 3. Diagram showing locations of soil samples taken at 90 C Avenue, Lodi, New Jersey (LJ079).

Table 1. Applicable guidelines for protection against radiation^a

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation levels (above background)	20 μ R/h
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100 m ² area ²³² Th ²³⁰ Th ²²⁸ Ra ²²⁶ Ra	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm thick soil layers more than 15 cm below the surface

^aReference 3.

Table 2. Background radiation levels for the northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure at 1 m above ground surface (μ R/h)	8 ^a
Concentration of radionuclides in soil (pCi/g)	
²³² Th	0.9 ^b
²³⁸ U	0.9 ^b
²²⁶ Ra	0.9 ^b

^aReference 4.^bReference 5.

Table 3. Concentrations of radionuclides in soil at
90 C Avenue, Lodi, New Jersey (LJ079)

Sample ^a	Depth (cm)	Radionuclide concentration (pCi/g)		
		²²⁶ Ra ^b	²³² Th ^b	²³⁸ U ^b
<i>Systematic samples^c</i>				
S1A	0-15	0.74±0.05	0.99±0.003	<1.3
S1B	15-30	0.73±0.1	0.96±0.06	<2.4
<i>Biased samples^d</i>				
B1A	0-15	1.6 ±0.2	12 ±0.6	<4.3
B1B	15-30	1.7 ±0.2	11 ±0.4	<5.0
B1C	30-45	1.1 ±0.1	4.1 ±0.1	<4.2
B1D	45-55	0.80±0.06	2.1 ±0.09	<0.92
B2A	0-15	1.4 ±0.09	8.4 ±0.3	<3.8
B2B	15-30	1.3 ±0.06	7.9 ±0.4	<4.9
B2C	30-45	0.82±0.01	2.4 ±0.03	<2.2
B3A	0-15	2.5 ±0.7	32 ±0.8	16 ±9.9
B3B	15-30	13 ±0.9	240 ±7	<48
B3C	30-45	1.5 ±0.2	18 ±0.7	e
B4A	0-15	0.88±0.03	4.1 ±0.07	<5.4
B4B	15-30	0.72±0.2	2.9 ±0.2	<2.1
B4C	30-45	0.72±0.08	2.1 ±0.09	<0.91
B5A	0-15	1.1 ±0.1	4.6 ±0.2	<2.2
B5B	15-30	1.3 ±0.04	9.3 ±0.1	<6.8
B6A	0-15	3.3 ±0.7	68 ±2	<28
B6B	15-30	0.95±0.08	5.5 ±0.2	<3.4
B6C	30-45	0.79±0.07	2.8 ±0.1	<2.0
B6D ^f	15-30	3.6 ±0.4	42 ±2	e
B6E ^f	0-15	3.6 ±1	110 ±4	<50
B6F ^f	0-15	4.2 ±0.9	84 ±2	<36
B6G ^f	0-15	3.7 ±0.4	64 ±1	<23

^aLocations of soil samples are shown on Fig. 3.

^bIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^cSystematic samples are taken at locations irrespective of gamma exposure rates.

^dBiased samples are taken from areas shown to have elevated gamma exposure rates.

^eBiased samples B3C and B6D were not analyzed for ²³⁸U.

^fBiased samples B6D-B6G were taken laterally at depths indicated to examine ash layer beneath concrete.

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